State of Utah - Division of Information Technology Services

UTAH AGRC Automated Geographic Reference Center

The Utah Reference Network GPS

UGIC 2008

Sean A. Fernandez, PLS

Automated Geographic Reference Center

AGRC Survey Efforts

- Provide technical support to the office of lieutenant governor in evaluating boundary creation or boundary changes prior to certification by the lieutenant governor.
- Assist the State Tax Commission in processing and quality assurance of boundary descriptions or maps into digital format for inclusion in the State Geographic Information Database.
- Coordinate with county recorders and surveyors to create a statewide parcel layer in the State Geographic Information Database.
- Facilitates and integrates the collection efforts of local government and federal agencies for data collection to densify and enhance the statewide Public Land Survey System reference network in the State Geographic Information Database.
- Coordinate the collection of Survey Control for Statewide Imagery.
- Manage and coordinate the development of The Utah Reference Network GPS project.

AGRC Survey Projects

- GCDB Corner Collection- New revised version delivered by BLM a few weeks ago.
- Improve workflow to include collected section corners much faster.
- Implement the Surveyor Office Web Site.
- Continue to add Parcel Data to the SGID.
- Coordinate the collection of Survey Control for Statewide Imagery.
- The Utah Reference Network GPS project.

The Utah Reference Network GPS

A little background

A need for statewide, high accuracy, real time GPS

Summary of the system (High accuracy GPS)

- This network would strategically locate GPS Reference Stations ranging from 20-50 kilometers in spacing utilizing existing facilities and existing base stations where feasible (An estimated 65-70 stations will be required). Probably closer to 80 stations.

- TURN GPS will provide statewide coverage for high accuracy GPS survey and mapping to improve the quality of geographic information system data and the productivity, efficiency, and cost-effectiveness of government services. Provide a complete GNSS Survey Solution for all surveyors in the State of Utah.

Progress and Direction

Credit where credit is due

- UDOT- Derek Peterson, Administration and Survey Crews
- County and Local Government Partners– Surveyors, GIS Users
- Local Vendors

July 2006

- July 2006 Non-Lapsing Funds = $500,000
- Request For Proposal
- Contract Awarded
- Partnerships Created
- Network Installs Begin

April 2007

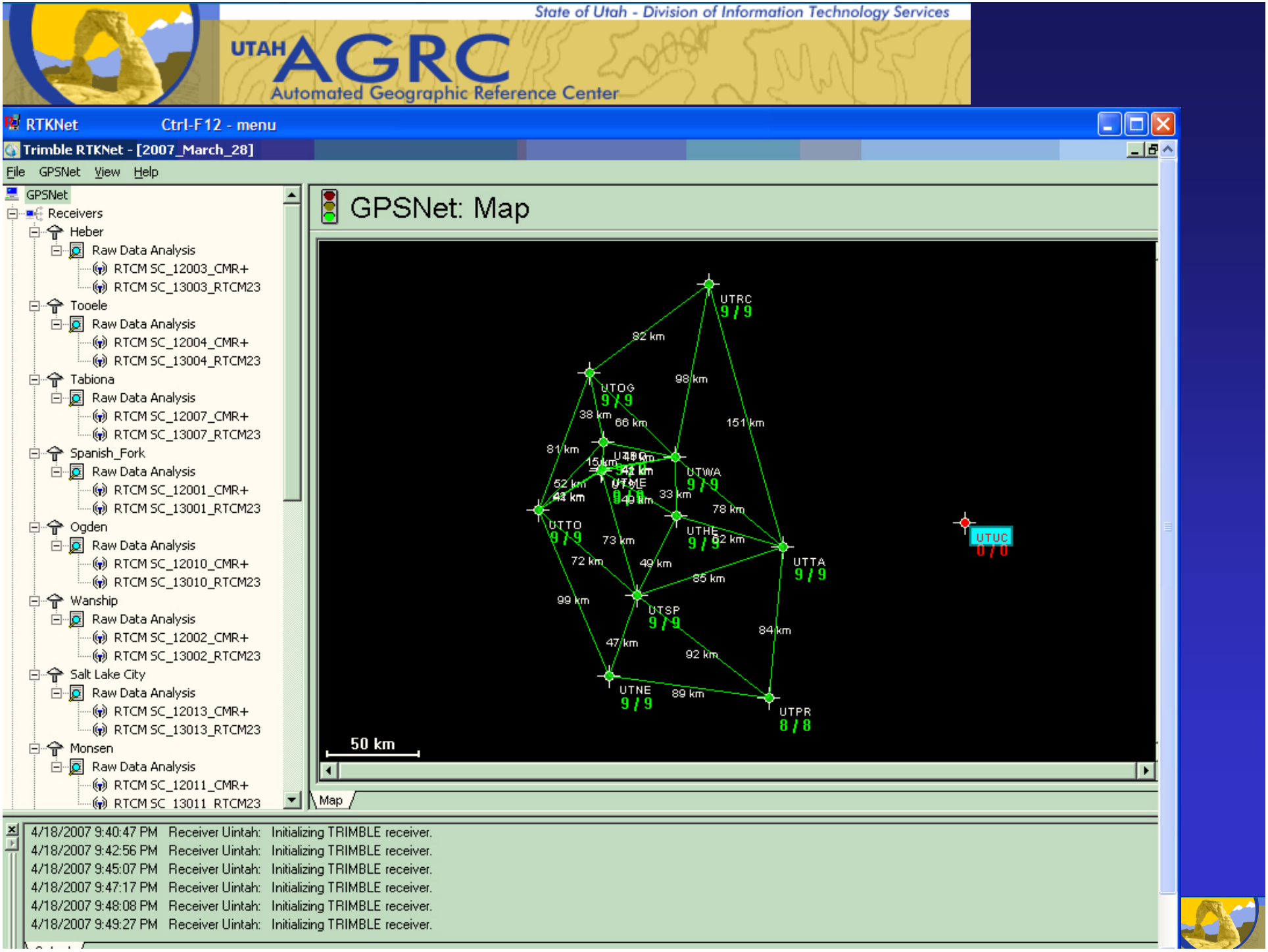
Initial Purchases (10 receivers, software, 3 servers) = $400,000

- 15 Receivers Installed
- Using Network RTK (Survey Grade)

  Imagery Control
- Testing Single Baseline Solution (Survey Grade & Mapping Grade)
- TURNGPS available at no charge April thru July 2007

January 2008

- 2006 Non-Lapsing Funds = $500,000
- 2007 Funds = $295,000
- 2008 Funds = $400,000
- 39 Receivers Installed
- 73 Paying Users
- 32 Partner Users


State of Utah - Division of Information Technology Services
UTAH AGRC
Automated Geographic Reference Center
RTKNet Ctrl-F12 - menu
Trimble RTKNet - [2007_March_28]
File GPSNet View Help
GPSNet
Receivers
Heber
Raw Data Analysis
RTCM SC_12003_CMR+
RTCM SC_13003_RTCM23
Tooele
Raw Data Analysis
RTCM SC_12004_CMR+
RTCM SC_13004_RTCM23
Tabiona
Raw Data Analysis
RTCM SC_12007_CMR+
RTCM SC_13007_RTCM23
Spanish_Fork
Raw Data Analysis
RTCM SC_12001_CMR+
RTCM SC_13001_RTCM23
Ogden
Raw Data Analysis
RTCM SC_12010_CMR+
RTCM SC_13010_RTCM23
Wanship
Raw Data Analysis
RTCM SC_12002_CMR+
RTCM SC_13002_RTCM23
Salt Lake City
Raw Data Analysis
RTCM SC_12013_CMR+
RTCM SC_13013_RTCM23
Monsen
Raw Data Analysis
RTCM SC_12011_CMR+
RTCM SC_13011_RTCM23
GPSNet: Map
UTRC 9 / 9
UTOG 9 / 9
UTWA 9 / 9
UTTO 9 / 9
UTHE 9 / 9
UTTA 9 / 9
UTSP 9 / 9
UTNE 9 / 9
UTPR 8 / 8
UTUC 0 / 0
82 km
98 km
151 km
38 km
66 km
81 km
52 km
43 km
33 km
78 km
73 km
72 km
49 km
85 km
99 km
84 km
47 km
92 km
89 km
50 km
Map
4/18/2007 9:40:47 PM Receiver Uintah: Initializing TRIMBLE receiver.
4/18/2007 9:42:56 PM Receiver Uintah: Initializing TRIMBLE receiver.
4/18/2007 9:45:07 PM Receiver Uintah: Initializing TRIMBLE receiver.
4/18/2007 9:47:17 PM Receiver Uintah: Initializing TRIMBLE receiver.
4/18/2007 9:48:08 PM Receiver Uintah: Initializing TRIMBLE receiver.
4/18/2007 9:49:27 PM Receiver Uintah: Initializing TRIMBLE receiver.

What have we learned?

- Incorrect coordinates cause problems (coordinate monitoring)
- Some Cellular Modems work much better than others
- Baselines exceeding 70 Kilometers provide good results in Horizontal, but questionably results in Vertical
- Surveyors and GIS Mappers still need to use good fundamentals and practices

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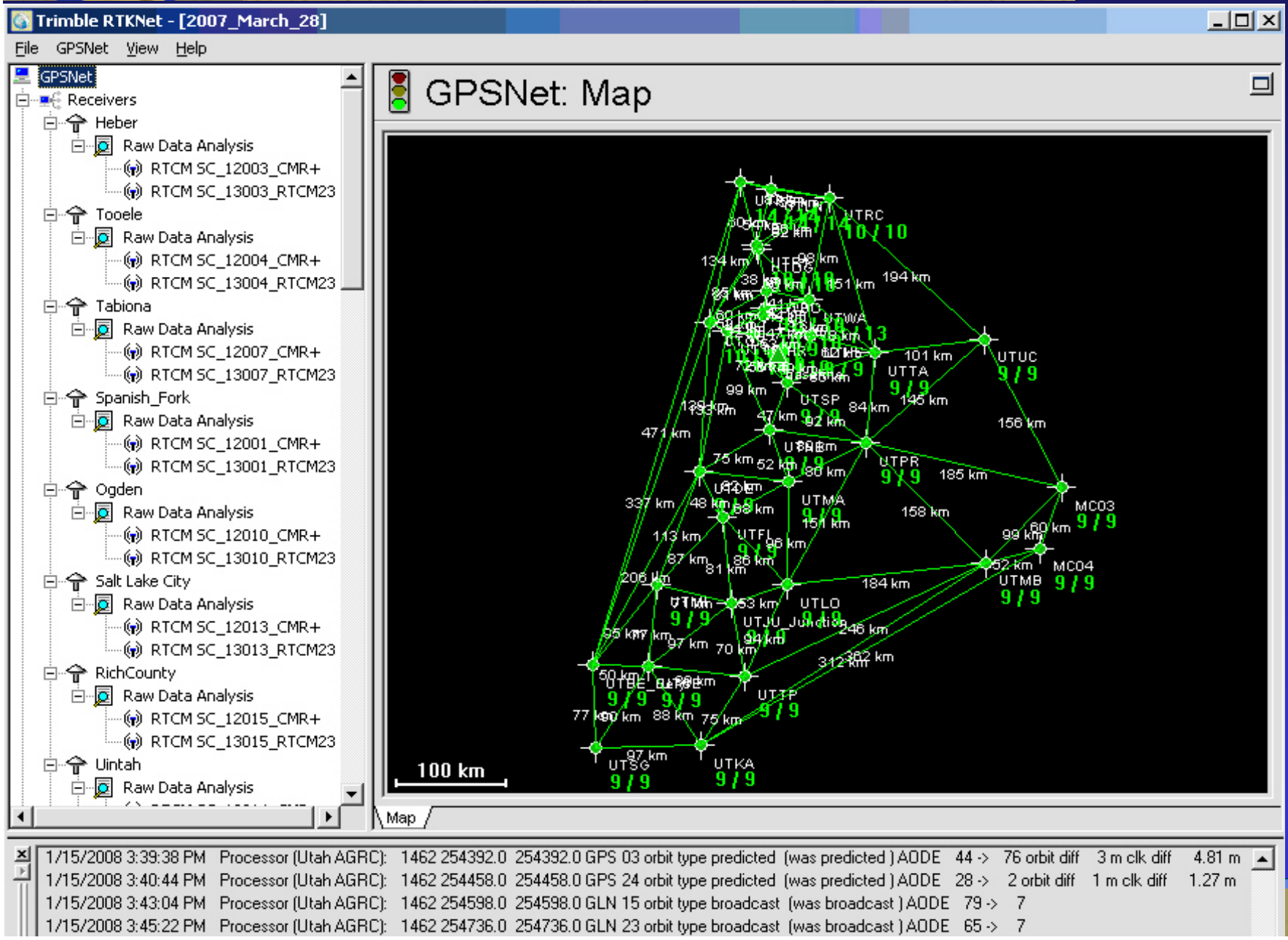
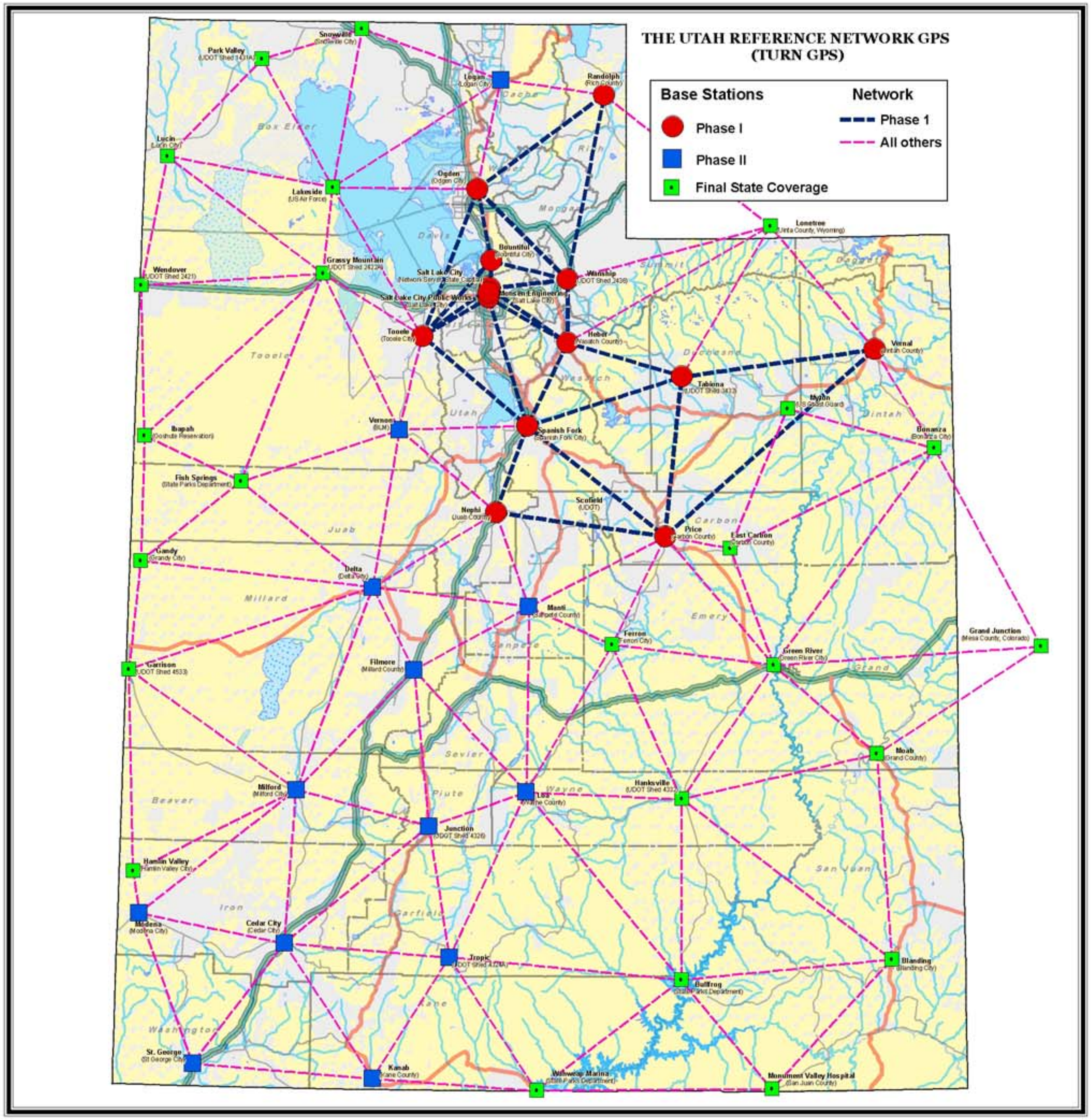
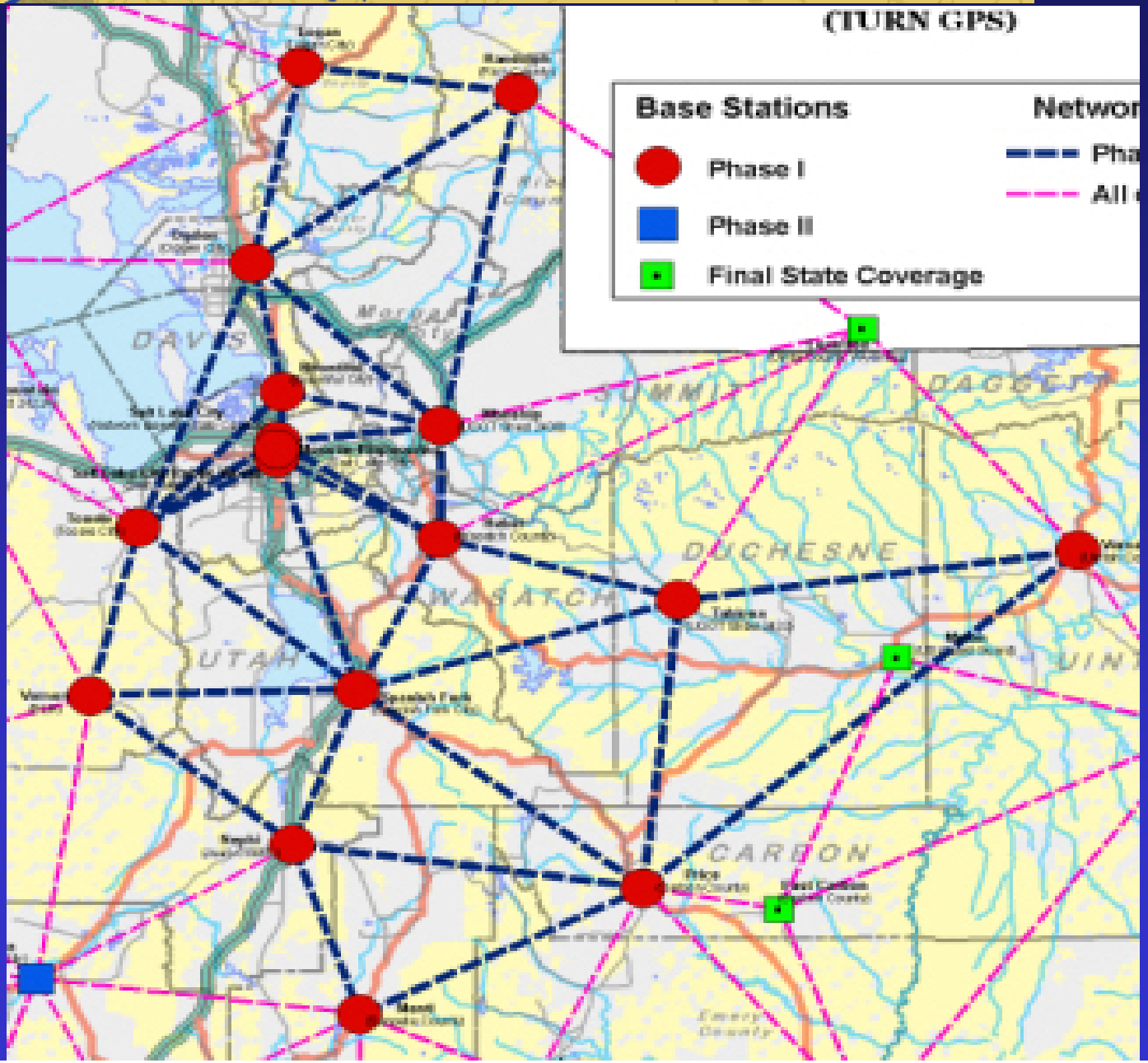
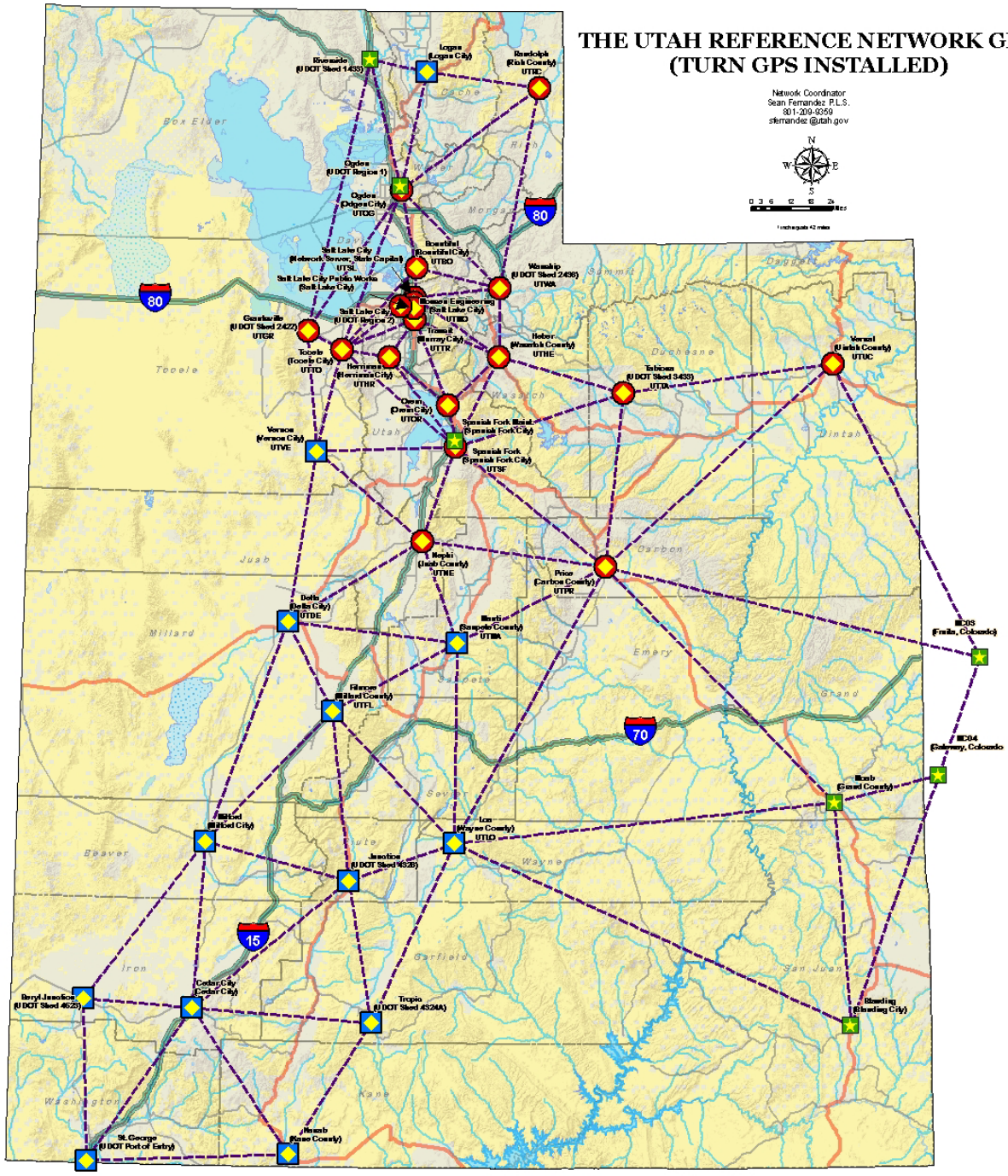



THE UTAH REFERENCE NETWORK GPS
(TURN GPS)
Base Stations
Phase I
Phase II
Final State Coverage
Network
Phase 1
All others
Snowville
Park Valley
Logan
Randolph
Lucin
Lakeside
Ogden
Lonetree
Bountiful
Wendover
Grassy Mountain
Salt Lake City
Wanship
Salt Lake City Public Works
Tooele
Heber
Vernal
Tabiona
Myton
Ibapah
Vernon
Spanish Fork
Bonanza
Fish Springs
Nephi
Scofield
Price
East Carbon
Gandy
Delta
Manti
Ferron
Grand Junction
Garrison
Filmore
Green River
Moab
Milford
Loa
Hanksville
Junction
Hamlin Valley
Modena
Cedar City
Tropic
Blanding
Bullfrog
St. George
Kanab
Wahweap Marina
Monument Valley Hospital
Box Elder
Cache
Rich
Morgan
Davis
Summit
Daggett
Tooele
Duchesne
Wasatch
Utah
Uintah
Juab
Carbon
Millard
Emery
Sanpete
Grand
Sevier
Piute
Wayne
Beaver
Iron
Garfield
San Juan
Kane
Washington

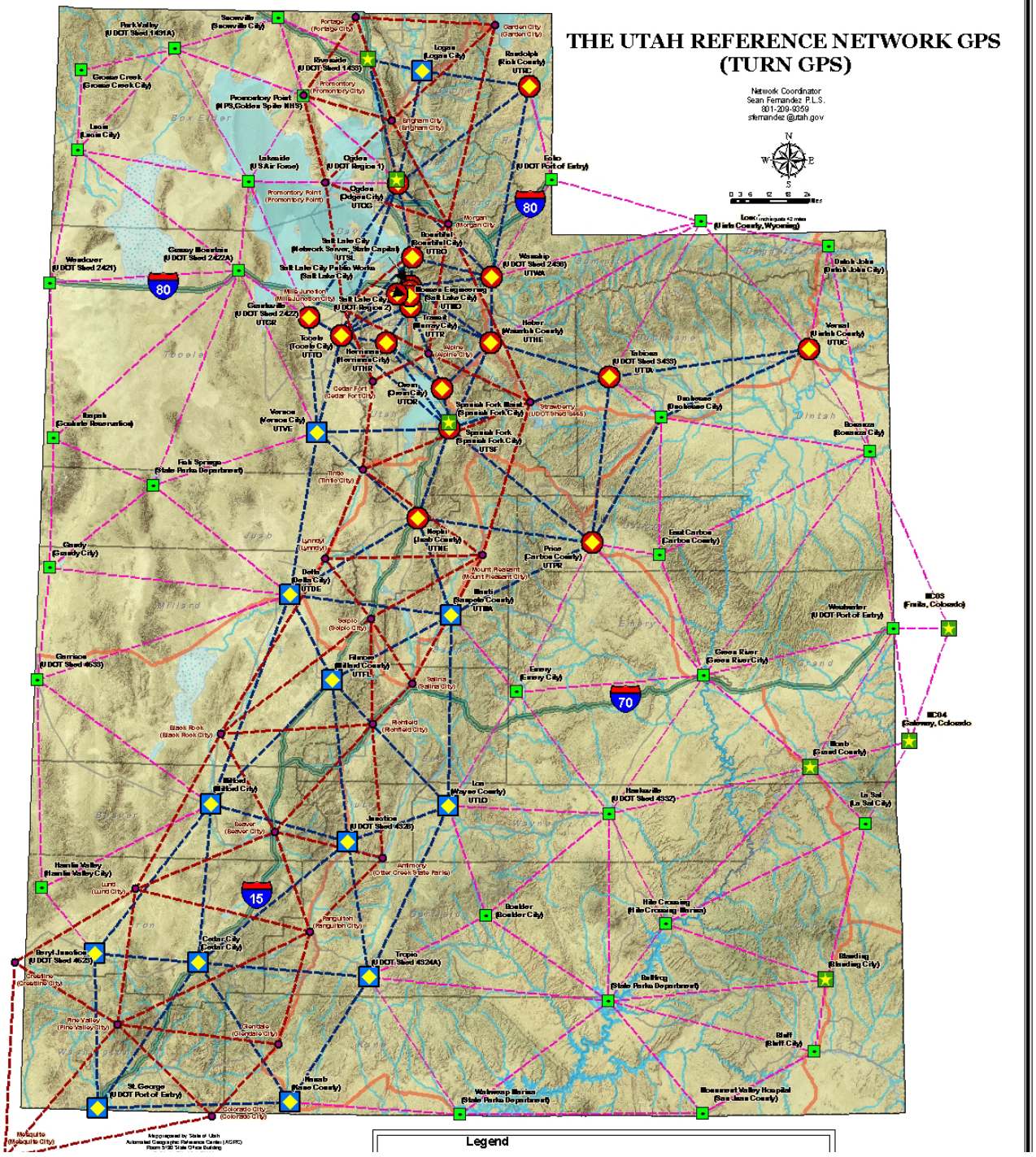

(TURN GPS)
Base Stations
Phase I
Phase II
Final State Coverage
DAVIS
DUCHESNE
UTAH
CARBON

THE UTAH REFERENCE NETWORK GPS (TURN GPS INSTALLED)

Network Coordinator
Sean Fernandez P.L.S.
801-209-9359
sfernandez@utah.gov



Legend


THE UTAH REFERENCE NETWORK GPS
(TURN GPS)
Network Coordinator
Sean Fernandez P.L.S.
801-209-9359
sfernandez@utah.gov
Legend

Network Components (3 Servers) Has not changed

- GPStream (Communications)

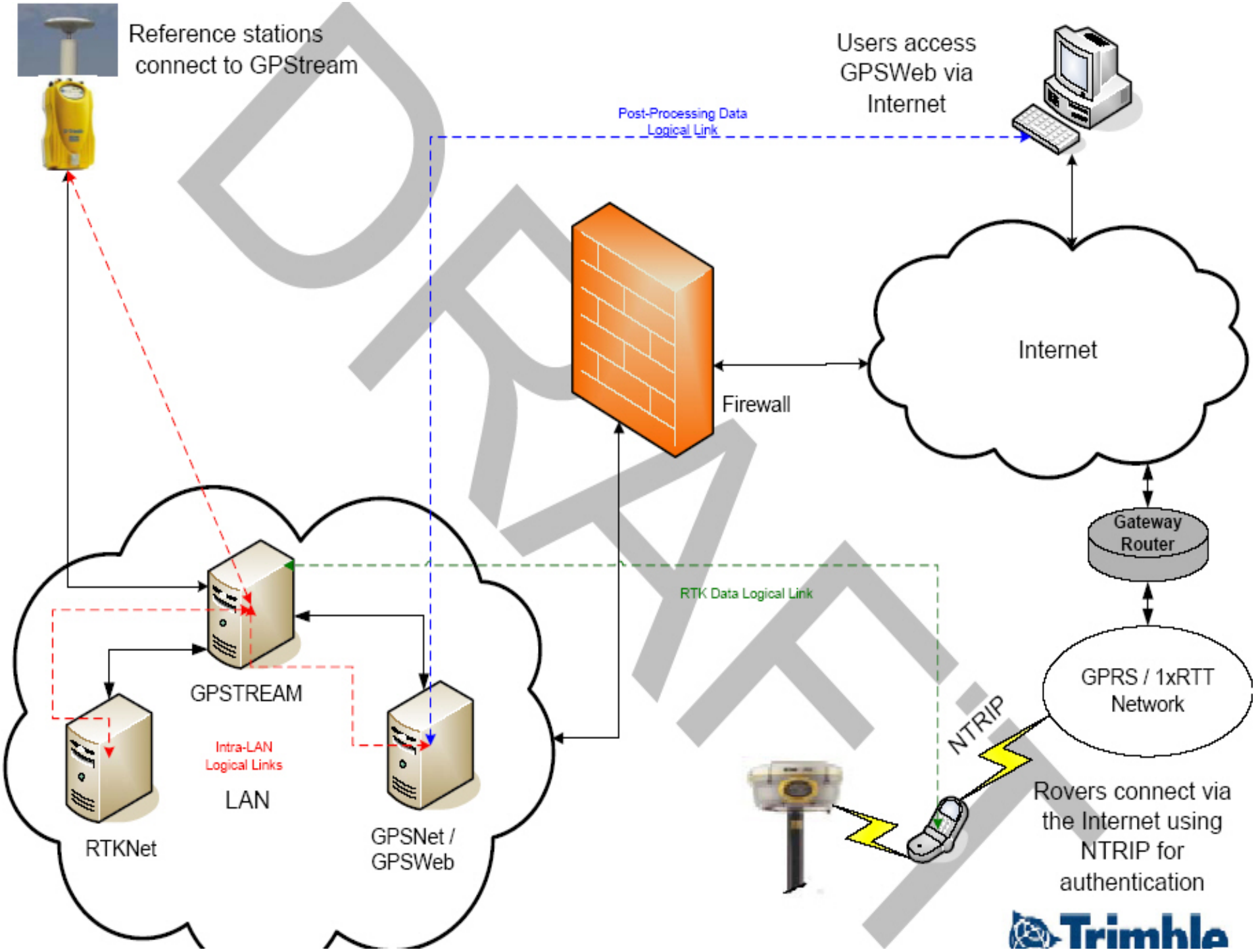
168.179.231.6

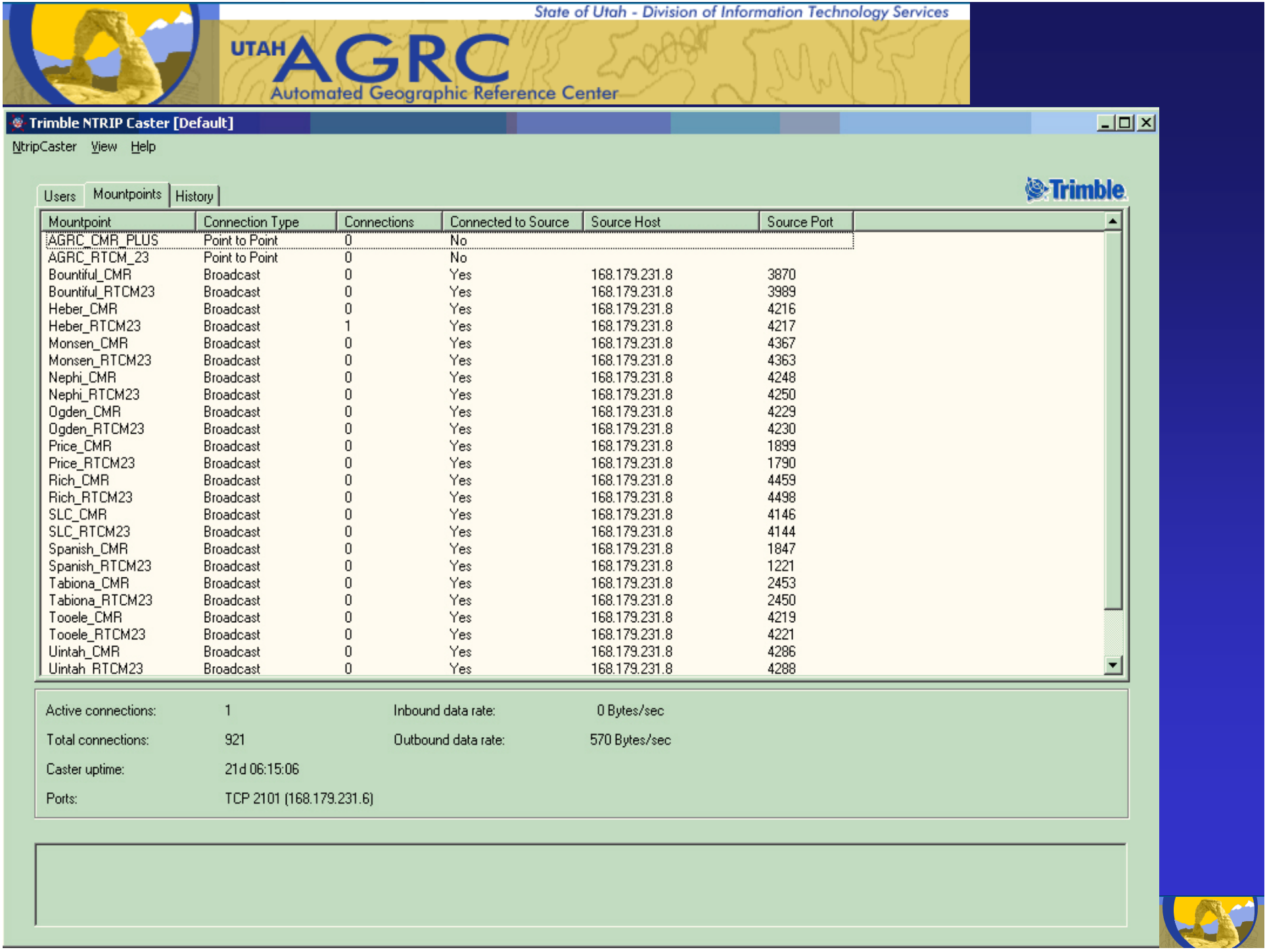
- GPSNet/GPSWeb (Raw data and Web)

168.179.231.7

- RTKNet (RTK Processing Engine)

168.179.231.8


Reference stations connect to GPStream
Users access GPSWeb via Internet
Post-Processing Data Logical Link
Firewall
Internet
Gateway Router
RTK Data Logical Link
GPRS / 1xRTT Network
NTRIP
GPSTREAM
Intra-LAN Logical Links
LAN
RTKNet
GPSNet / GPSWeb
Rovers connect via the Internet using NTRIP for authentication
Trimble
DRAFT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Trimble NTRIP Caster [Default]
NtripCaster View Help
Users Mountpoints History
Trimble
Mountpoint Connection Type Connections Connected to Source Source Host Source Port
AGRC_CMR_PLUS Point to Point 0 No
AGRC_RTCM_23 Point to Point 0 No
Bountiful_CMR Broadcast 0 Yes 168.179.231.8 3870
Bountiful_RTCM23 Broadcast 0 Yes 168.179.231.8 3989
Heber_CMR Broadcast 0 Yes 168.179.231.8 4216
Heber_RTCM23 Broadcast 1 Yes 168.179.231.8 4217
Monsen_CMR Broadcast 0 Yes 168.179.231.8 4367
Monsen_RTCM23 Broadcast 0 Yes 168.179.231.8 4363
Nephi_CMR Broadcast 0 Yes 168.179.231.8 4248
Nephi_RTCM23 Broadcast 0 Yes 168.179.231.8 4250
Ogden_CMR Broadcast 0 Yes 168.179.231.8 4229
Ogden_RTCM23 Broadcast 0 Yes 168.179.231.8 4230
Price_CMR Broadcast 0 Yes 168.179.231.8 1899
Price_RTCM23 Broadcast 0 Yes 168.179.231.8 1790
Rich_CMR Broadcast 0 Yes 168.179.231.8 4459
Rich_RTCM23 Broadcast 0 Yes 168.179.231.8 4498
SLC_CMR Broadcast 0 Yes 168.179.231.8 4146
SLC_RTCM23 Broadcast 0 Yes 168.179.231.8 4144
Spanish_CMR Broadcast 0 Yes 168.179.231.8 1847
Spanish_RTCM23 Broadcast 0 Yes 168.179.231.8 1221
Tabiona_CMR Broadcast 0 Yes 168.179.231.8 2453
Tabiona_RTCM23 Broadcast 0 Yes 168.179.231.8 2450
Tooele_CMR Broadcast 0 Yes 168.179.231.8 4219
Tooele_RTCM23 Broadcast 0 Yes 168.179.231.8 4221
Uintah_CMR Broadcast 0 Yes 168.179.231.8 4286
Uintah_RTCM23 Broadcast 0 Yes 168.179.231.8 4288
Active connections: 1
Inbound data rate: 0 Bytes/sec
Total connections: 921
Outbound data rate: 570 Bytes/sec
Caster uptime: 21d 06:15:06
Ports: TCP 2101 (168.179.231.6)

Available Formats for Users

NETWORK SOLUTION

- RTCM 2.3
- RTCM 3.0
- CMR+

SINGLE BASE LINE SOLUTION

- RTCM 2.3
- RTCM 3.0
- CMR+

Building a Quality Network for Today and the Future

Managing Network Dynamics

- (GNSS) Global Navigation Satellite System
- Accurate Rover Positioning
- Accurate Reference Station Locations

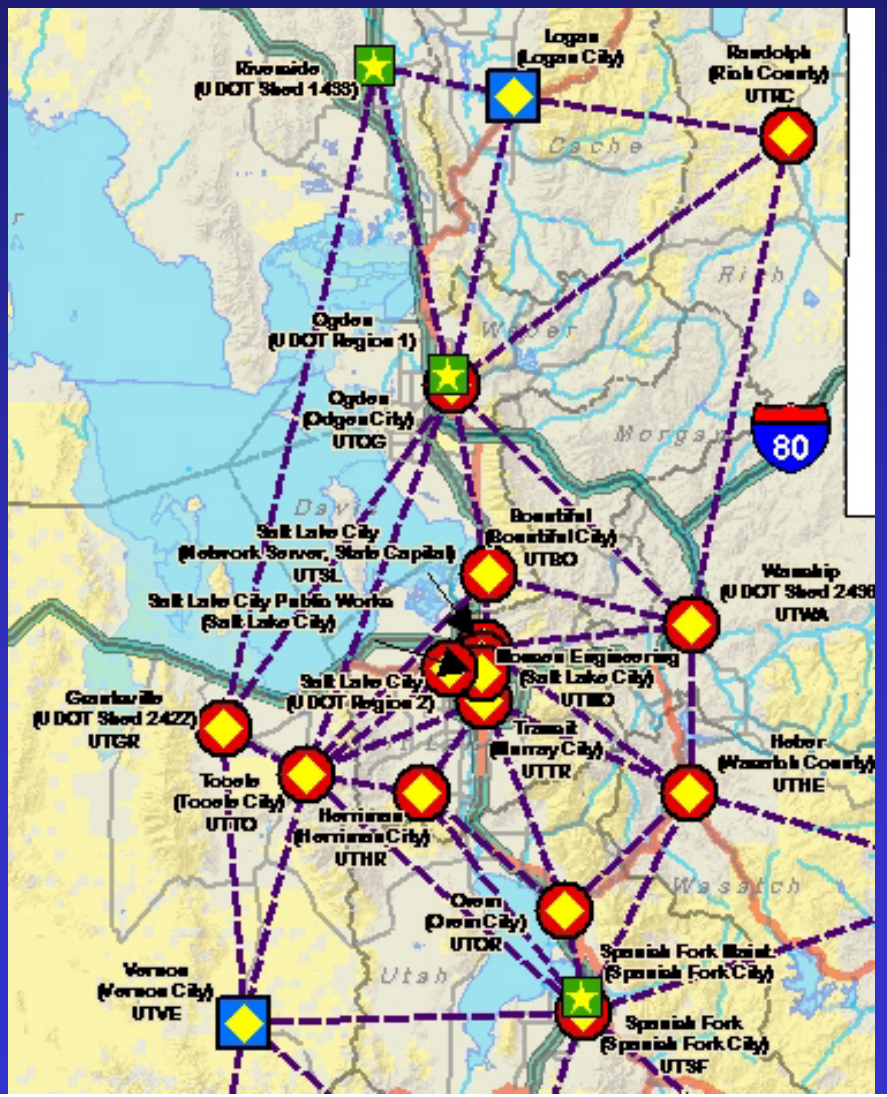
GNSS
(Global Navigation Satellite System)

Moving from GPS to GNSS

The Trimble NetR5 reference station and Zephyr Geodetic antenna.

NetR5 Installs

- Logan
- Riverside
- Ogden
- Grantsville
- Wanship
- Spanish Fork
- Moab
- UDOT SLC



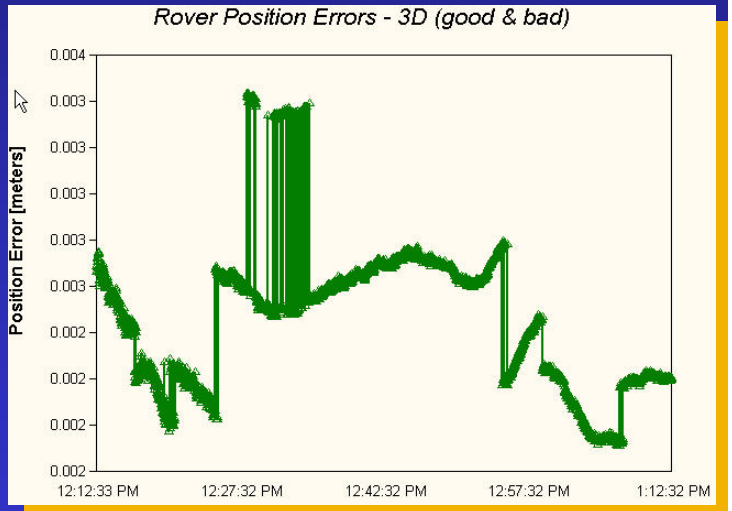
Accurate Rover Positioning

Rover Integrity Module

90 day demo license

Rover Integrity fundamentals

- What is it?
  - Permanently installed rover using your network solution to initialize and provide positioning quality statistics
  - Compares keyed in reference position to a calculated rover position
  - Includes statistics, feedback in real time, daily reports, alarms



Rover Integrity fundamentals

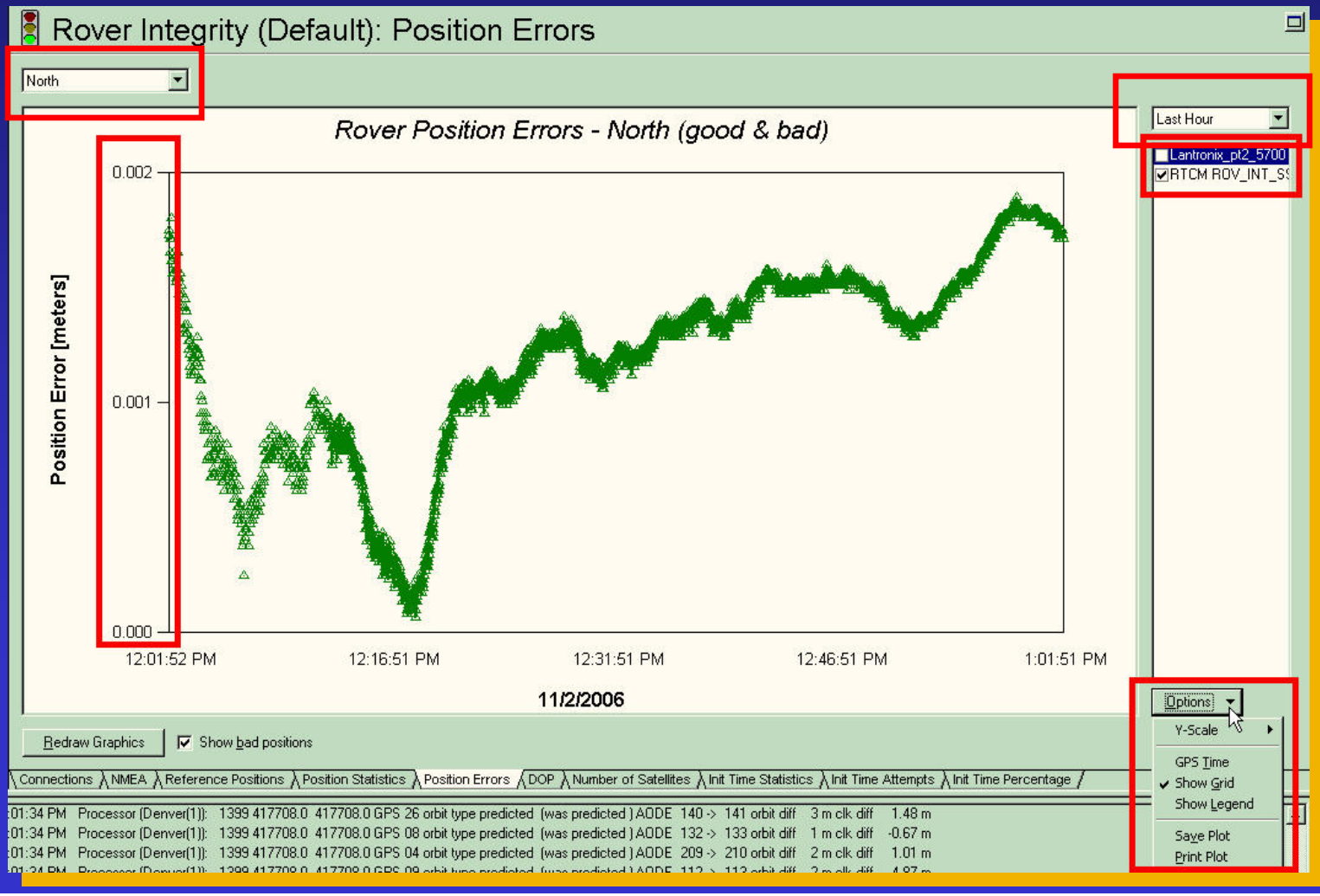
- Why do it?
  - Provides COMPLETE CONFIDENCE in your network solution
  - Allows you to complete the data cycle; see your network solution applied at your permanent rover

Rover-Status	GGK 11/2/2006 8:18:44 PM, 39.897943° -105.112709° 1666.831m, VRS_FIX, 9 sats, PDOP 1.6

Rover Integrity fundamentals

- How does it work?
  - RTKNet solution applied by Rover Integrity receiver
  - Rover Integrity Receiver MUST include RTK engine to initialize (NetR5 or 5700)
  - Receiver returns NMEA position which is compared to the reference position

Analysis


Rover Integrity (Default): Position Errors
North
Rover Position Errors - North (good & bad)
Position Error [meters]
0.002
0.001
0.000
12:01:52 PM
12:16:51 PM
12:31:51 PM
12:46:51 PM
1:01:51 PM
11/2/2006
Last Hour
Lantronix_pt2_5700
RTCM ROV_INT_S
Options
Y-Scale
GPS Time
Show Grid
Show Legend
Save Plot
Print Plot
Redraw Graphics
Show bad positions
Connections
NMEA
Reference Positions
Position Statistics
Position Errors
DOP
Number of Satellites
Init Time Statistics
Init Time Attempts
Init Time Percentage
01:34 PM Processor (Denver(1)): 1399 417708.0 417708.0 GPS 26 orbit type predicted (was predicted) AODE 140 -> 141 orbit diff 3 m clk diff 1.48 m
01:34 PM Processor (Denver(1)): 1399 417708.0 417708.0 GPS 08 orbit type predicted (was predicted) AODE 132 -> 133 orbit diff 1 m clk diff -0.67 m
01:34 PM Processor (Denver(1)): 1399 417708.0 417708.0 GPS 04 orbit type predicted (was predicted) AODE 209 -> 210 orbit diff 2 m clk diff 1.01 m

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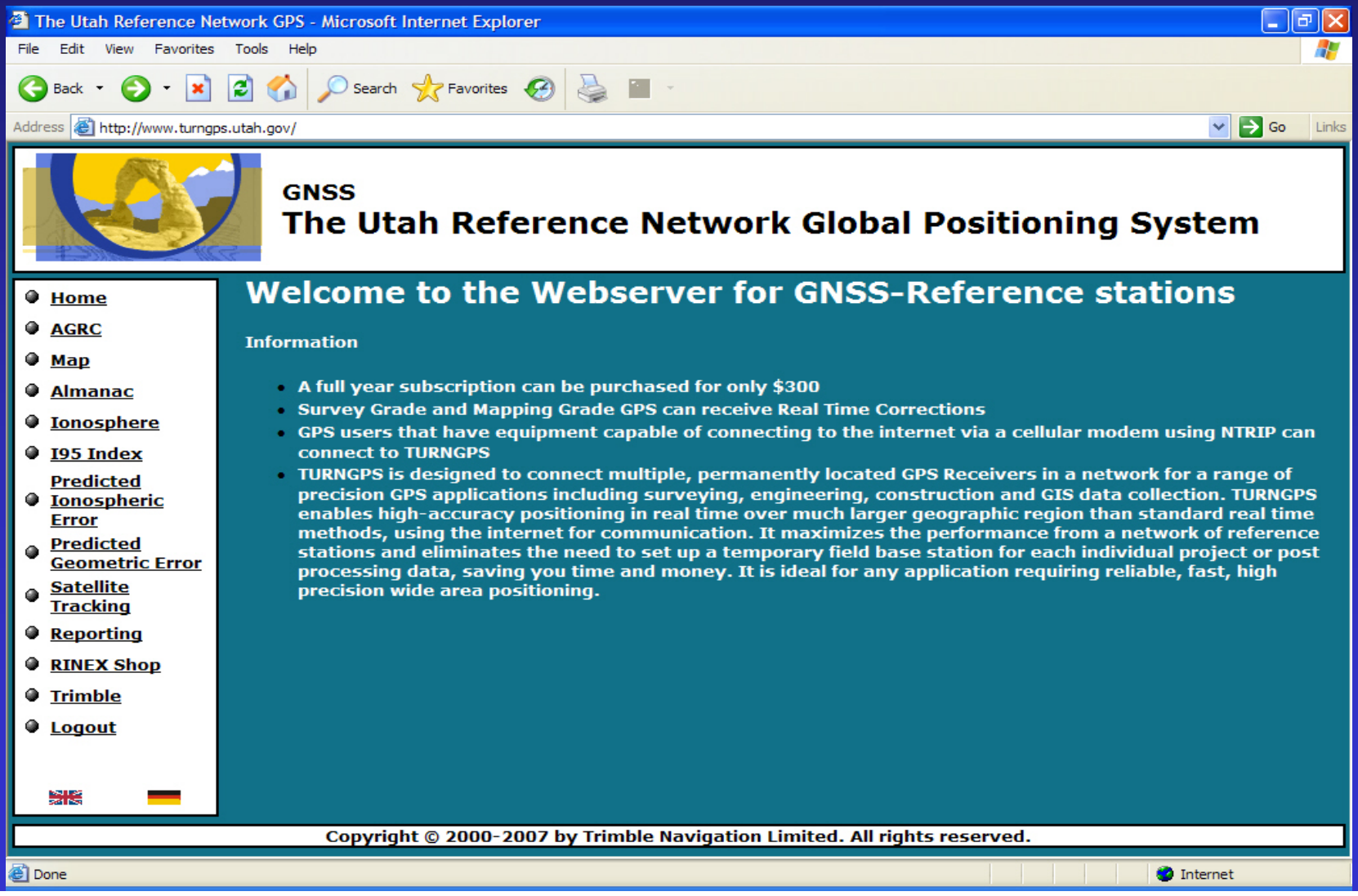
Analysis from Website



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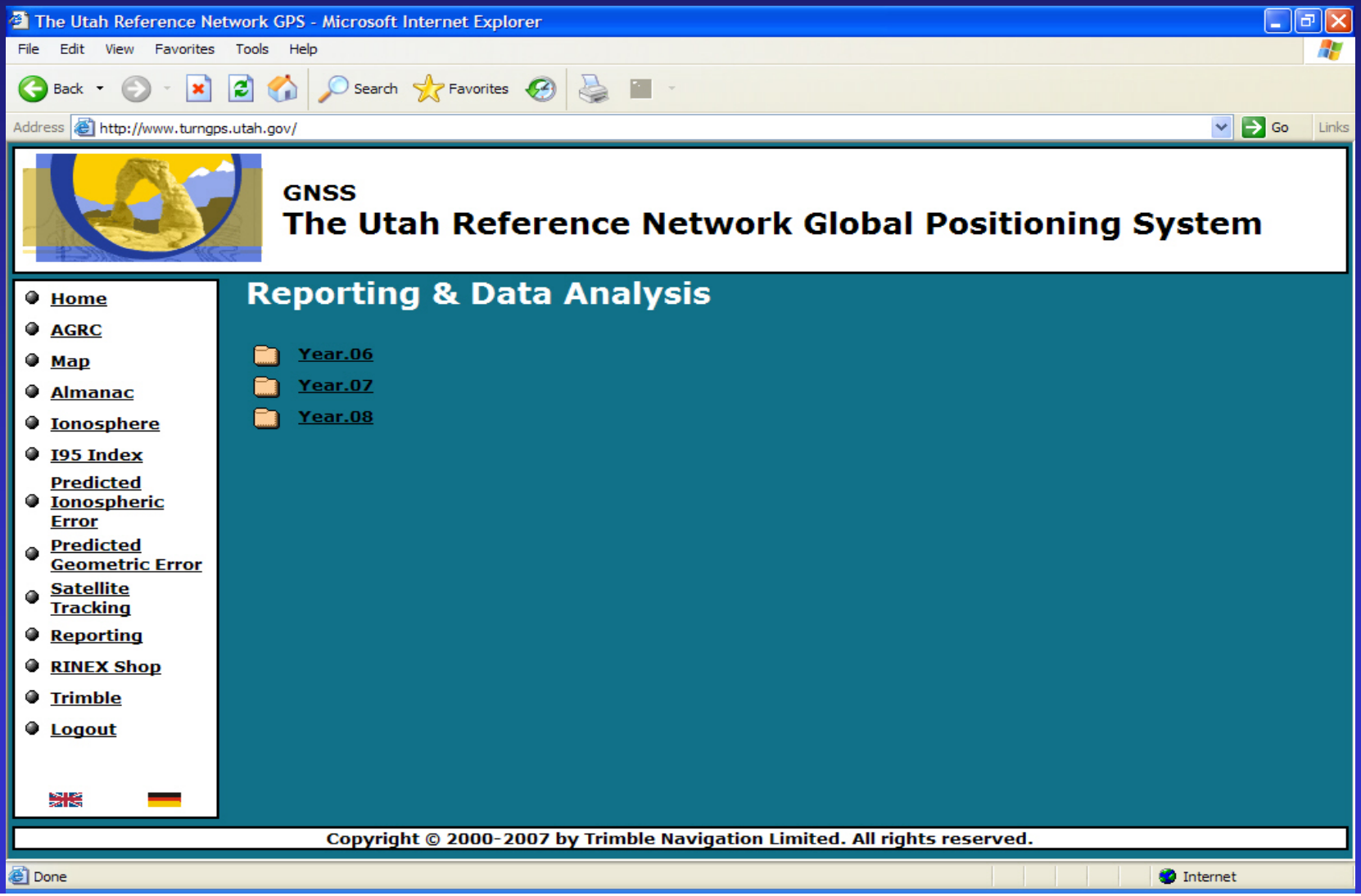
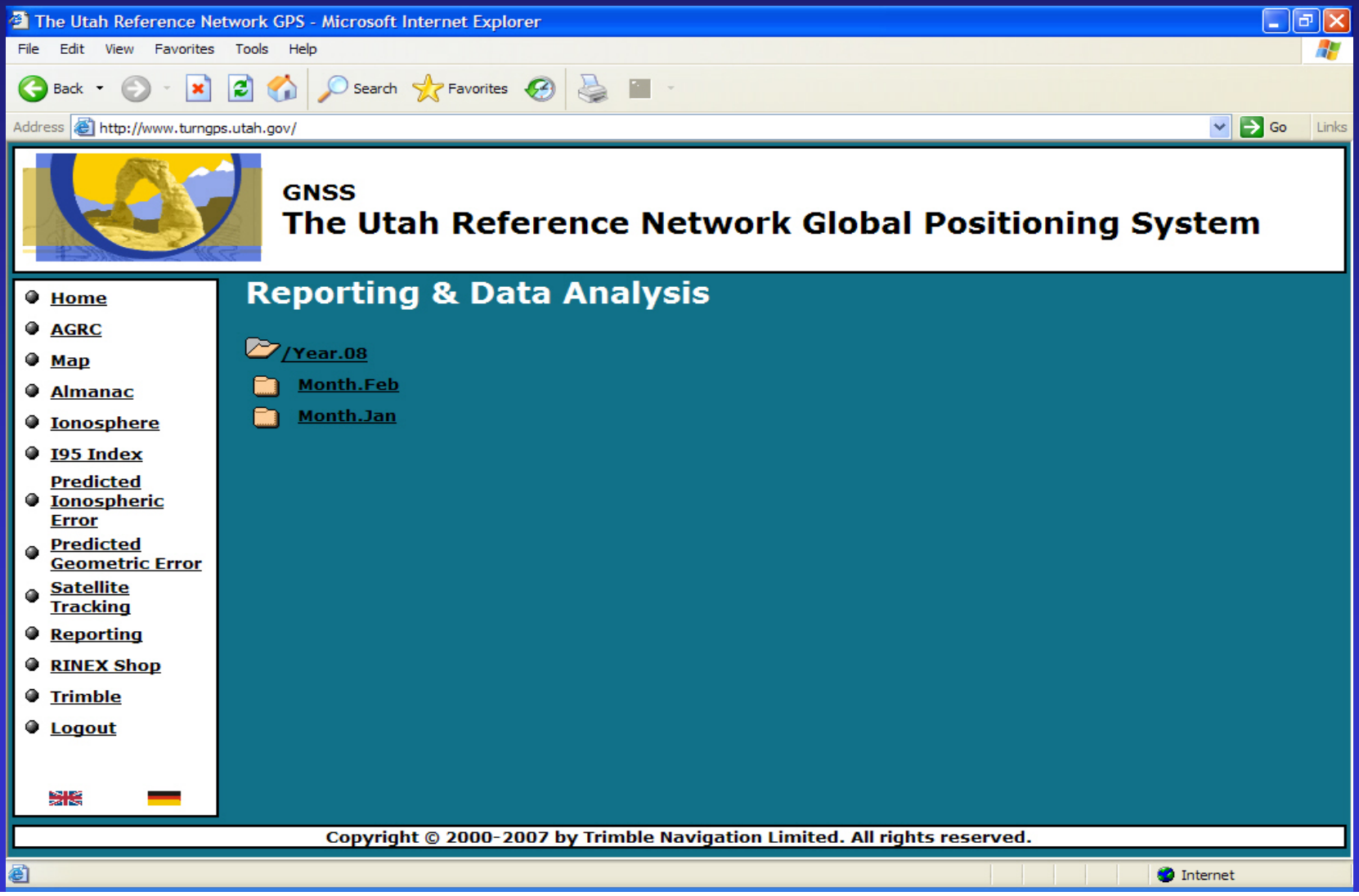
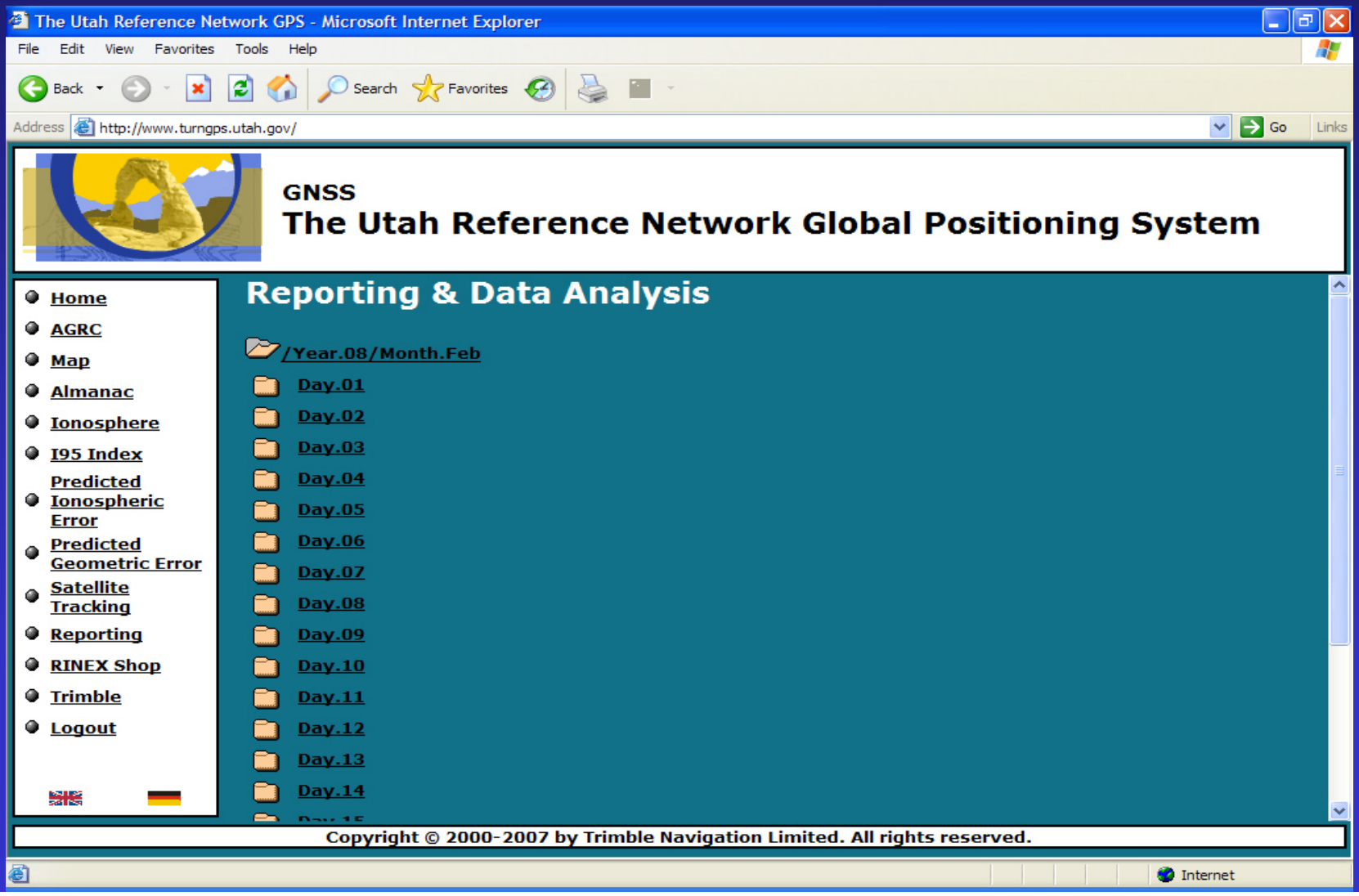


Analysis from Website



Analysis from Website



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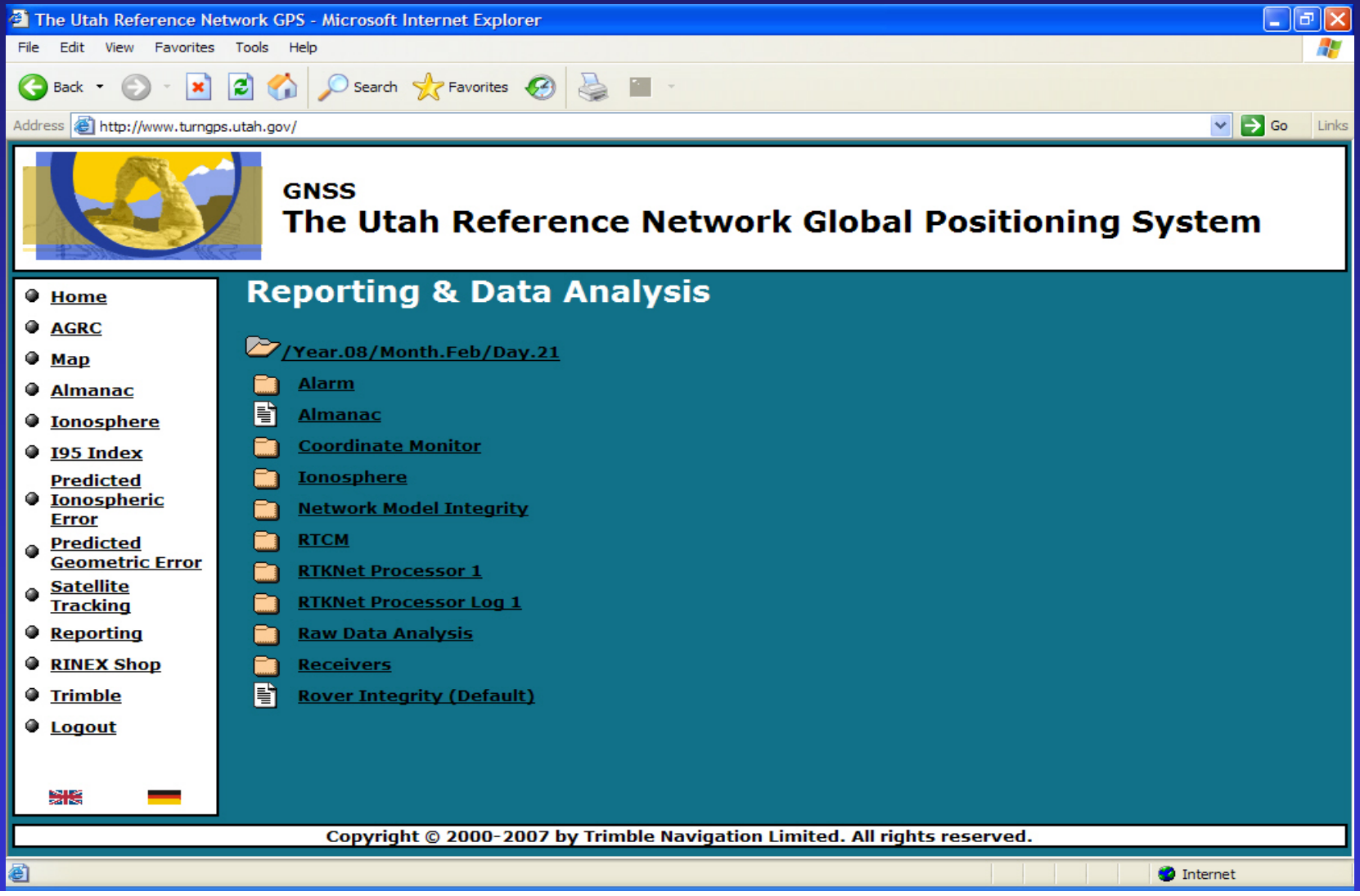
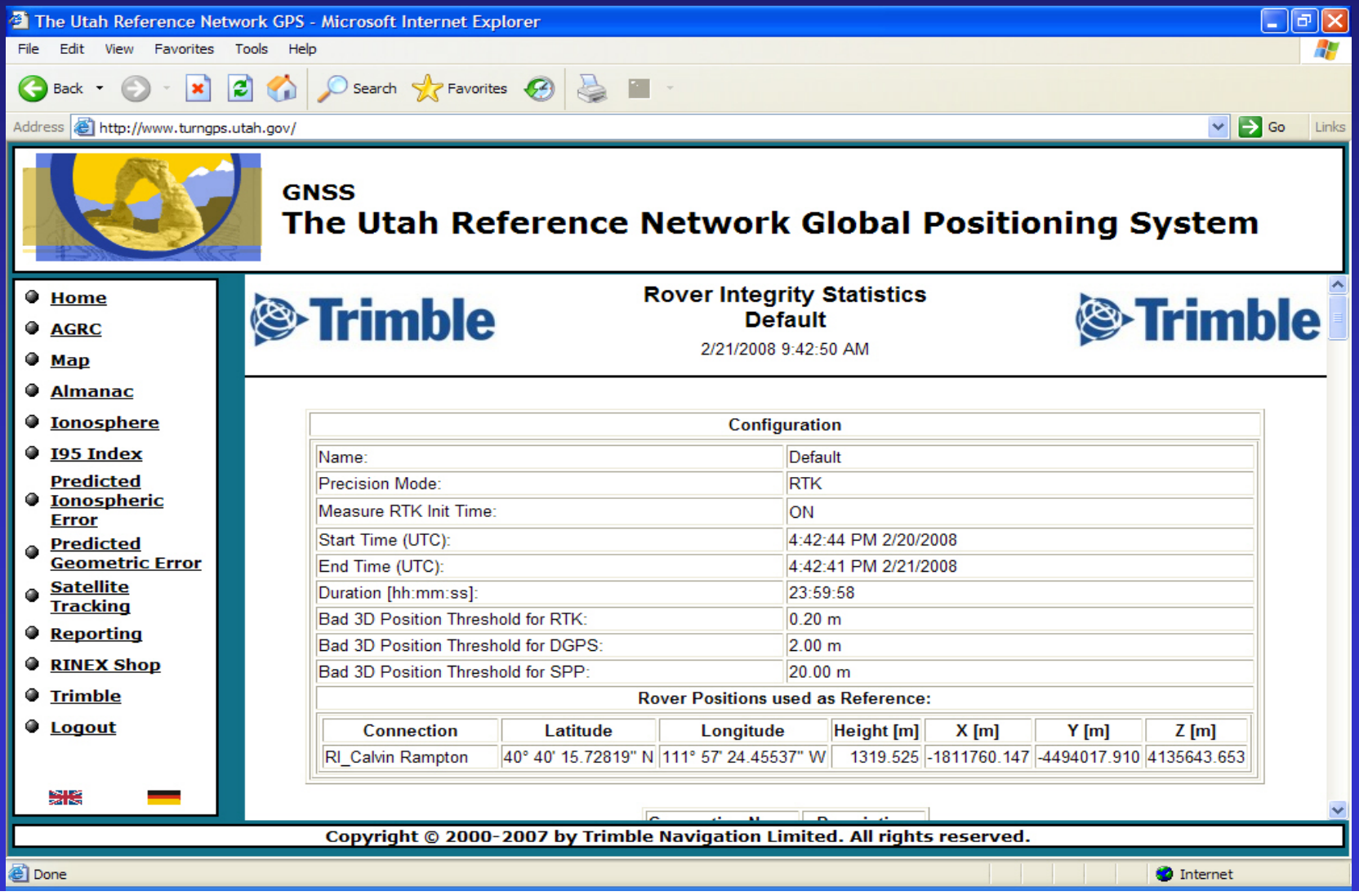
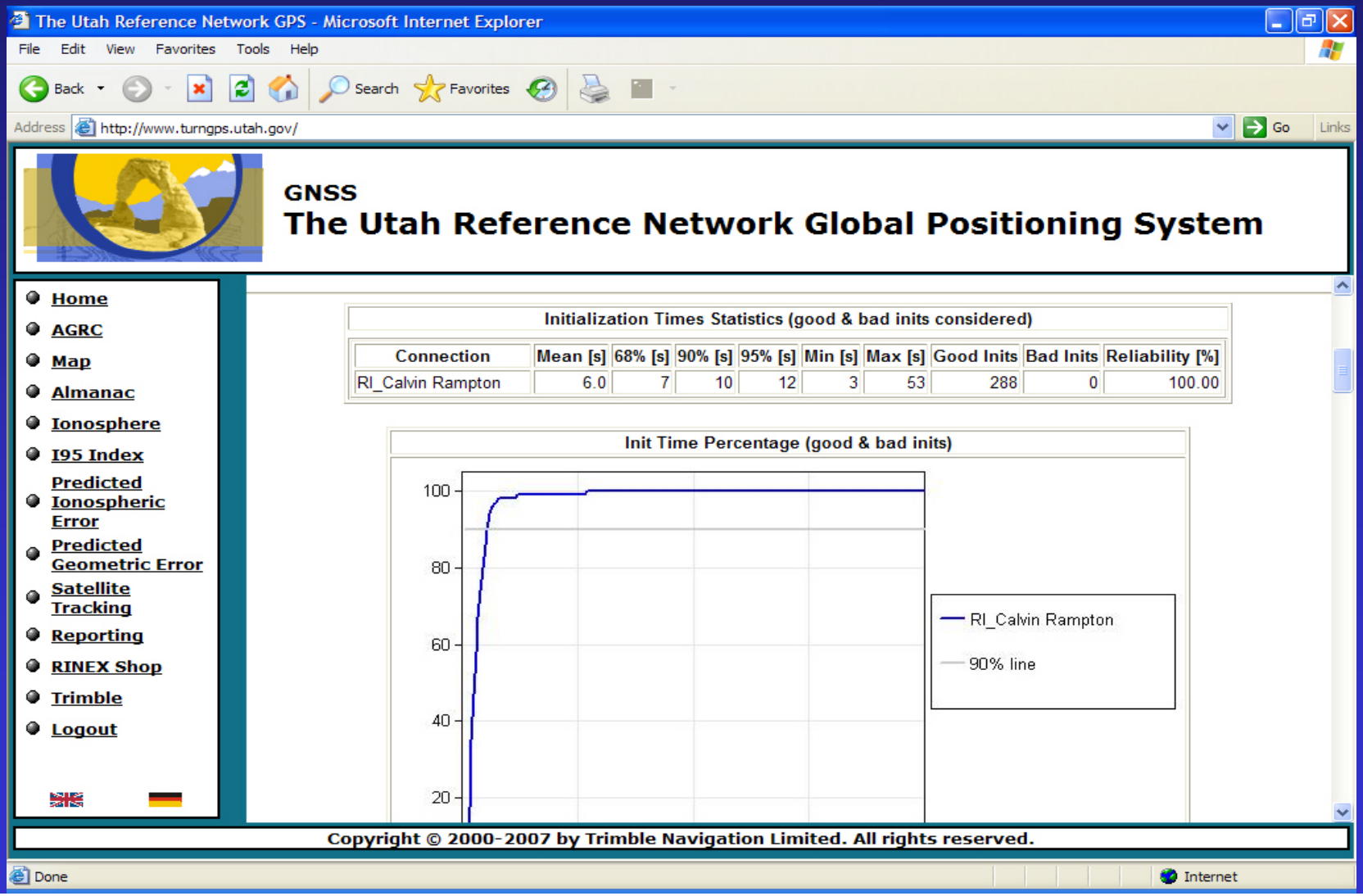


Analysis from Website



Analysis from Website



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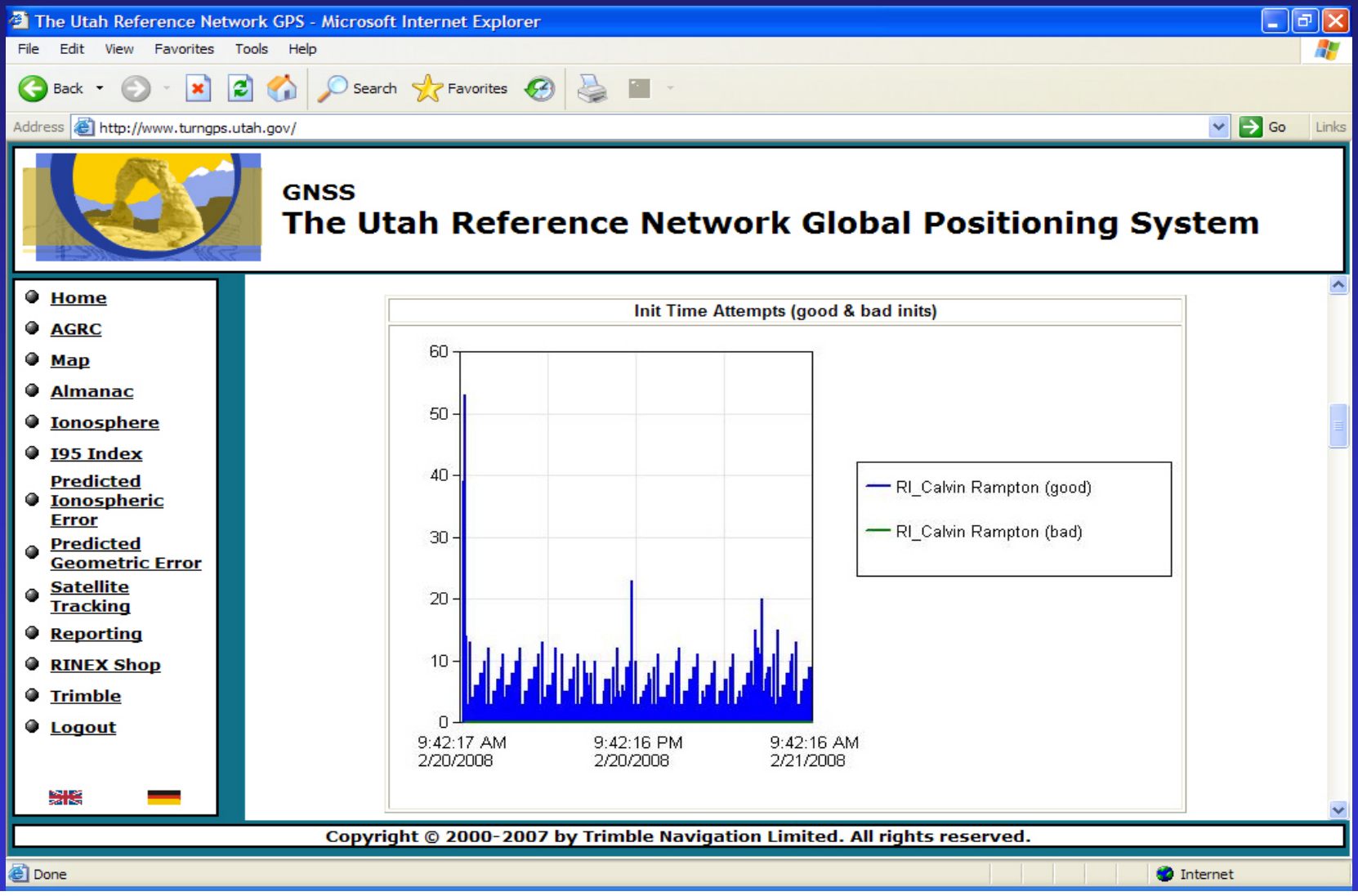

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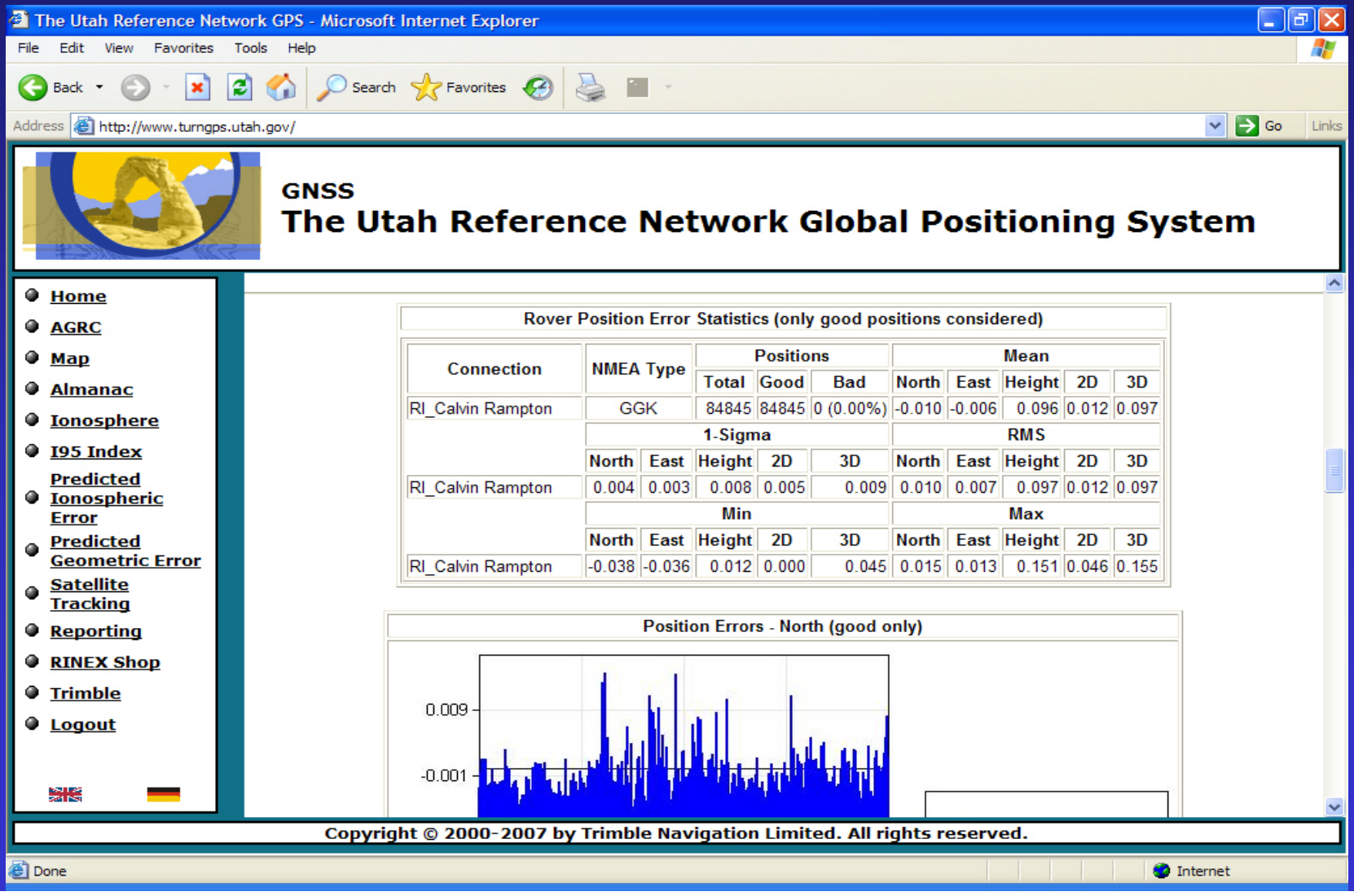
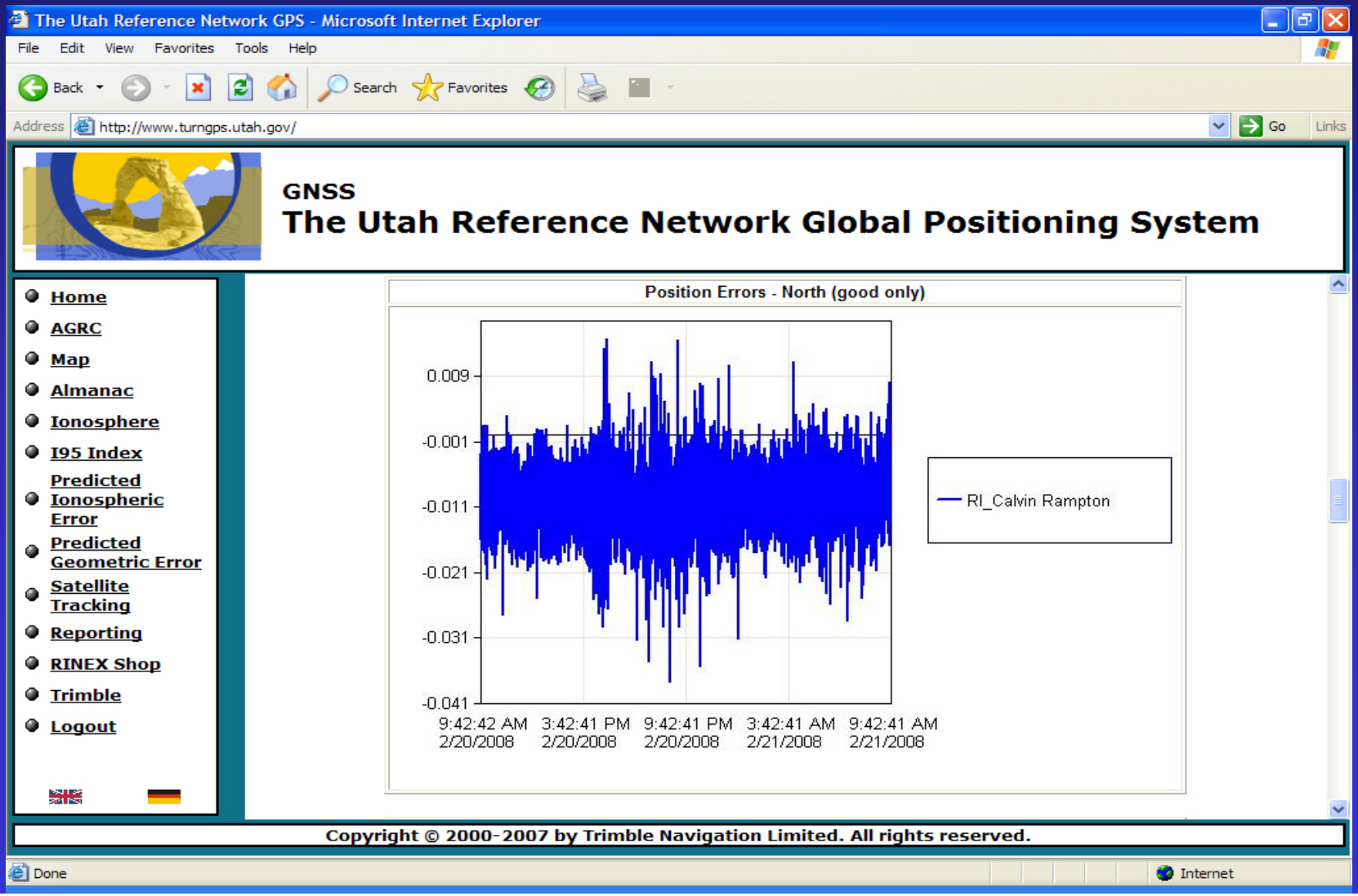
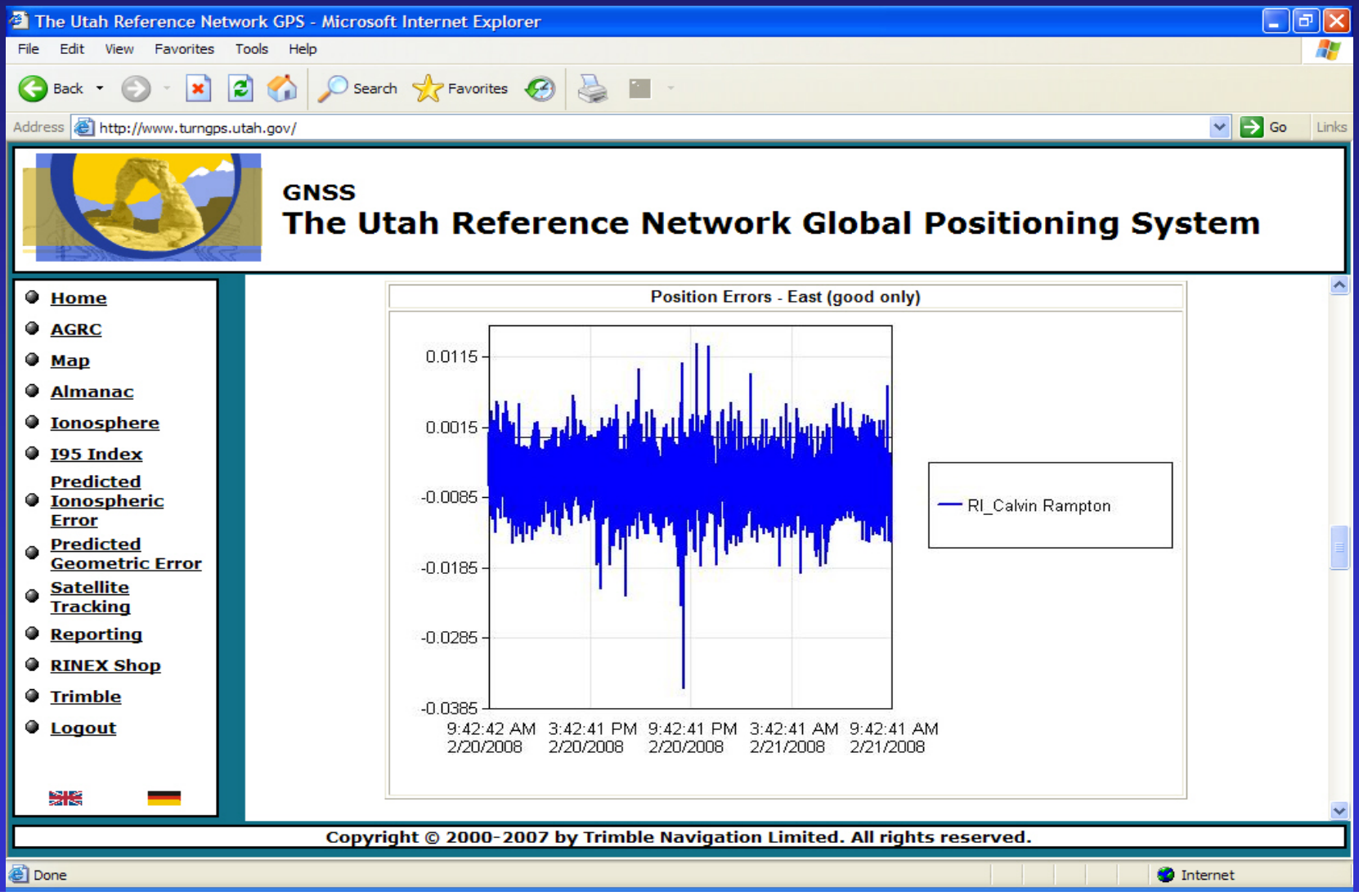


Connection	NMEA Type	Positions			Mean				
		Total	Good	Bad	North	East	Height	2D	3D
RI_Calvin Rampton	GGK	84845	84845	0 (0.00%)	-0.010	-0.006	0.096	0.012	0.097
		1-Sigma					RMS		
		North	East	Height	2D	3D	North	East	Height	2D	3D
RI_Calvin Rampton		0.004	0.003	0.008	0.005	0.009	0.010	0.007	0.097	0.012	0.097
		Min					Max				
		North	East	Height	2D	3D	North	East	Height	2D	3D
RI_Calvin Rampton		-0.038	-0.036	0.012	0.000	0.045	0.015	0.013	0.151	0.046	0.155

Analysis from Website



Analysis from Website



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Analysis from Website

The Utah Reference Network GPS - Microsoft Internet Explorer

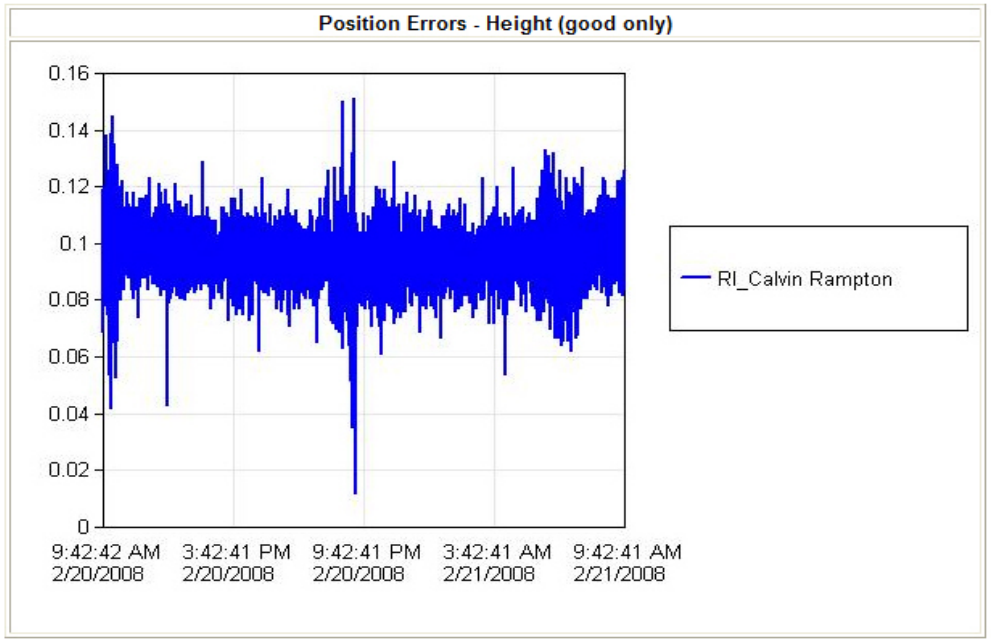
File Edit View Favorites Tools Help

Back Search Favorites

Address http://www.turngps.utah.gov/ Go Links

GNSS
The Utah Reference Network Global Positioning System

- Home
- AGRC
- Map
- Almanac
- Ionosphere
- I95 Index
- Predicted Ionospheric Error
- Predicted Geometric Error
- Satellite Tracking
- Reporting
- RINEX Shop
- Trimble
- Logout



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Done Internet

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Analysis from Website

The Utah Reference Network GPS - Microsoft Internet Explorer

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GNSS
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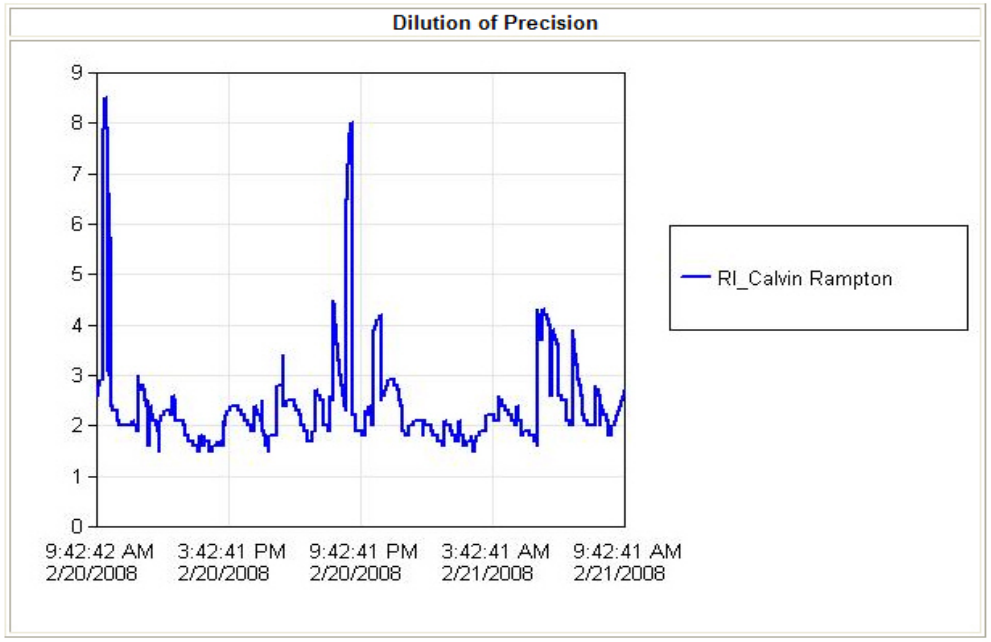

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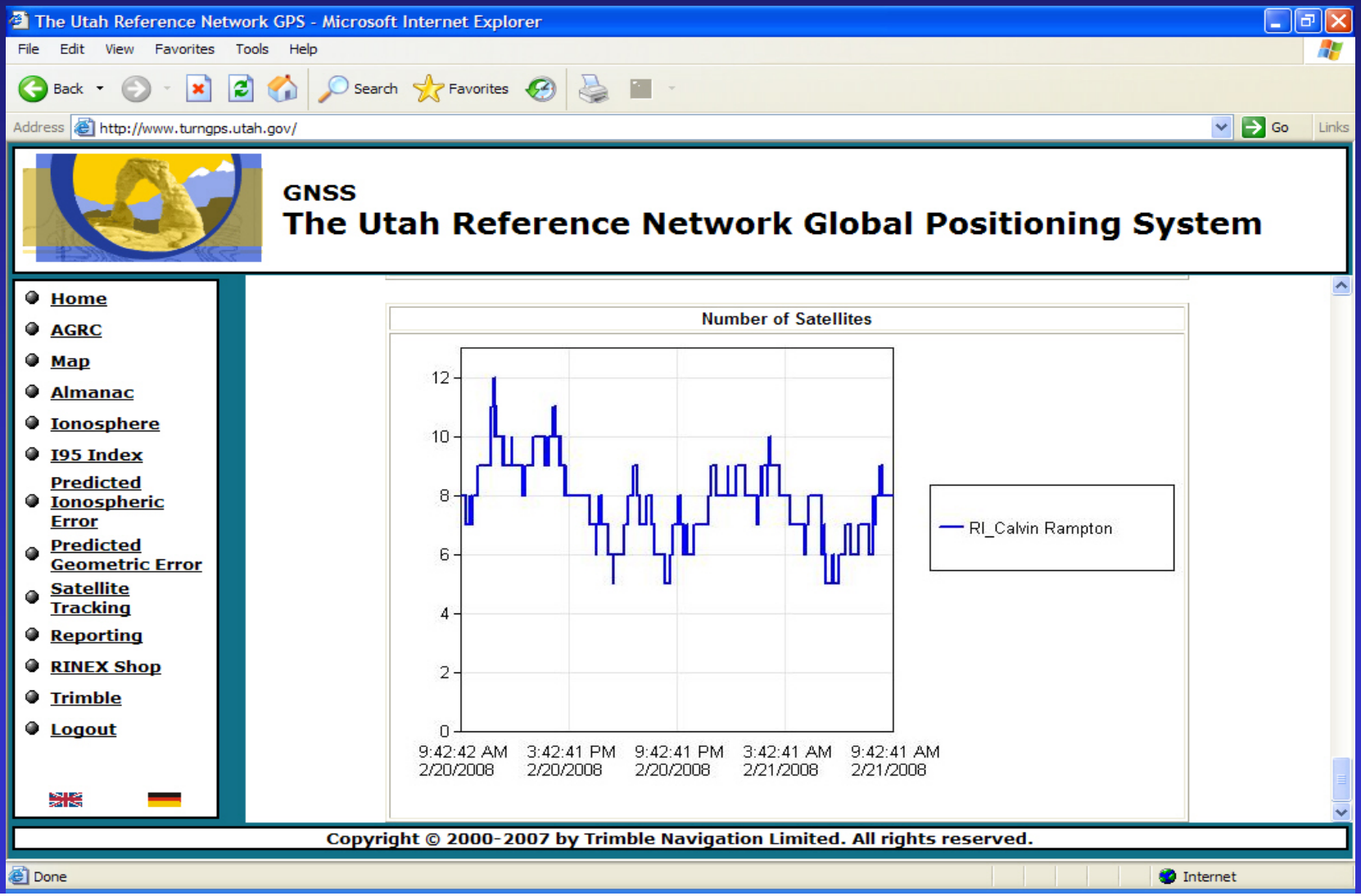
Done Internet

Analysis from Website



Accurate Reference Station Locations

Integrity Manager

Possible purchase with 2008 funds

Rapid Motion Engine

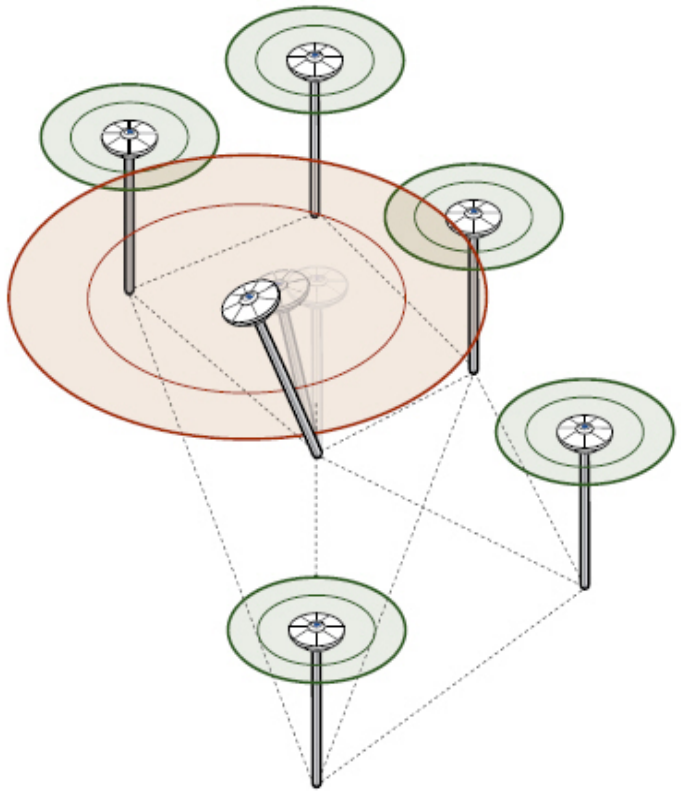
Significant motion has happened and you need to know

Velocity,

Alarm

- Uses proprietary algorithms to detect sudden change
- Runs parallel filters to detect rapid change greater than 3 cm/second

Integrity Manager- Abrupt Changes



With Trimble Integrity Manager, you can respond to abrupt position changes immediately and can better interpret long-term motion and displacement.

RME Sample Chart

Post Processing Engine

Plate tectonics, coordination

Control, Precision

- Most precise coordinates
- Slow reaction time
- Uses RINEX, DAT or T01
- Automatic baseline processing up to 2000 km

Distributor Confidential

TURNGPS 2008 Adjustment

REF FRAME: NAD_83(CORS96)(EPOCH:2002.0000)

TURNGPS 2008 Adjustment derived from the average of 3 OPUS solutions at least 4 days apart,
24 hour files, logged at a 15 second rate, using a precise ephemeris

	TURNGPS 2007 Adjustment			TURNGPS 2008 Adjustment			Adjustment Difference 2007 to 2008		
Station ID	Latitude	Longitude	Height	Latitude	Longitude	Height	Latitude	Longitude	Height
UTJU	38° 14' 41.30135"N	112°13'14.81947"W	1828.236(m)	38° 14' 41.30163"N	112°13'14.81935"W	1828.225(m)	0°00'0.00028	0°00'0.00012	0.011(m)
UTSP	40^06'33.69401" N	111^39'19.26063" W	1401.958(m)	40° 6' 33.69388"N	111°39'19.26082"W	1401.927(m)	0°00'0.00013	0°00'0.00019	0.031(m)

Application Components (GPS Reference Stations)

Tabiona, UDOT Maintenance Shed

IP: 208.5.87.53 PORT:5018

Manti, Sanpete County Court House

Randolph, Rich County Courthouse

Millard County

Estimated Cost for Annual Administration

- Software Licensing Maintenance per yr. = $19,950
- ITS Server Administration per yr. = $20 ,000
- Network Administrator Salary per yr. = $60,000
- Hardware/Firmware Maintenance x 70 = $44,800
- Ongoing Hardware Replacement
  10 per year = $150,000

= $294,750

Registration and Online Bill Pay

- www.turngps.utah.gov

Return Registration Email

- Thank you for registering with TURNGPS. Please read the terms and conditions before using this service.
- Terms and Conditions
- Users of this service must understand that this GPS Network is a cooperative effort involving many partners, and some GPS reference stations are located in facilities that may only be accessible during regular business hours. Therefore, those stations may not be available during regular business hours if a problem occurs. The AGRC (Automated Geographic Reference Center) will make all efforts to keep this service operating to its fullest potential where possible.
- Users of this service understand that **support** for connecting devises **will not** be provided by the State AGRC. Support should be provided by local vendors.
- DATA USE WARNING: We provide these data in good faith and shall in no event be liable for any lost profits and special, indirect or consequential damages to any party, arising out of or in connection with the use or the inability to use the data hereon or the services provided. We provide these data and services as a convenience to the public. Furthermore, we reserve the right to change or revise published data and/or these services at any time.
- Users are responsible to use standard surveying practices and due diligence to check and verify the accuracy of this service for their own work.
- The following username and password can be used for connecting to TURNGPS and logging into TURNGPS Web Site: www.turngps.utah.gov
- IP ADDRESS: 168.179.231.6
- PORT: 2101
- USERNAME:
- PASSWORD:

Questions?